Children and adolescent's violent deaths – epidemiological aspects in the North of Portugal between 2008 and 2012

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RESUMO

As crianças e os adolescentes são um grupo muito importante das nossas sociedades, pois representam o futuro e, para proteger as suas vidas, é necessário entender como morrem. Quais são as etiologias médico-legais e as causas responsáveis pela perda dos jovens membros das nossas sociedades? O objectivo deste estudo foi rever, retrospectivamente, os relatórios das autópsias médico-legais relativos a crianças e adolescentes, do Norte de Portugal, de 2008 a 2012, de forma a melhor compreender os eventos responsáveis pelas mortes violentas destes jovens. Foi registado um total de 151 casos, representando 1.38% das 10,906 autópsias médico-legais realizadas. Foi observado um decréscimo no número total de casos de 2009 a 2012. As vítimas do sexo masculino foram predominantes (60.9%), com um rácio masculino/feminino de 1.56:1. A idade média das vítimas foi 11.1 anos. Os adolescentes (12-17 anos), seguidos das crianças (0-2 anos), foram os grupos etários onde se registaram mais casos. Os resultados mostraram que a principal etiologia médico-legal observada foi morte acidental (87.4%), seguida de suicídio (6.6%) e homicídio (3.3%). Os acidentes de viação foram, no geral, o principal mecanismo de morte (54.3%), maioritariamente, atropelamentos (35% dos acidentes de viação), seguidos de afogamentos (17.9%). O enforcamento foi o método mais utilizado nos suicídios (40% dos suicídios) e 60% dos homicídios foram cometidos com recurso a armas de fogo. Há uma necessidade de implementar um sistema nacional de recolha sistemática de dados e de melhorar a pesquisa sobre esta temática, para entender melhor estes acontecimentos e para ser capaz de planear e implementar medidas de prevenção.

Palavras-chave: morte violenta, criança, adolescente, acidente

ABSTRACT

Children and adolescents are a very important group of our societies, as they represent the future and, in order to protect their lives, we need to understand how they die. What are the manners and causes responsible for the loss of the younger members of our societies? The aim of this study was to retrospectively review the autopsy reports, pertaining to children and adolescents, of the North of Portugal from 2008 to 2012, in order to better understand the events responsible for the violent deaths of these youngsters. A total of 151 cases were registered, representing 1.38% of the 10,906 forensic autopsies performed. A decrease in the total number of cases was observed from 2009 to 2012. Male victims were predominant (60.9%), with a male/female ratio of 1.56:1. The average victim's age was 11.1 years old. Adolescents (12-17 y), followed by infants (0-2 y), were the ages with most cases registered. Results showed accidents to be the leading manner of death (87.4%), followed by suicides (6.6%) and homicides (3.3%). Traffic accidents were the major overall mechanism of death (54.3%), mainly with pedestrian victims (35% of the traffic accidents), followed by drowning (17.9%). Hanging was the most utilized method in suicides (40% of the suicides) and 60% of the homicides were committed with firearms. There is a need to implement a national systematic data collection system and improve research on the subject, to better understand childhood deaths and be able to plan and implement preventive measures.

Keywords: violent death, children, adolescents, accident

1. Introduction

Every death is a tragedy which brings pain and grief to those left behind, but violent deaths of children are especially devastating, being extremely difficult for parents to cope with it [1,2].

Children and adolescents are an eclectic mix of people with a great importance as the future of society, as they are the ones who will succeed the present generation, yet there are lacking long-term comprehensive studies on their deaths in the forensic literature.

Infant mortality not only measures a nation's health, but it is also important as a worldwide indicator of health status and social well-being. Therefore, the death of a child is not only a problem of public health but also a social matter [3,4].

In spite of their great importance, children and adolescents are exposed to many risk factors which can lead to their unexpected death. In fact, unnatural injuries are one of the main causes of death in this age group in most countries [5].

Infants and children have poor physical strength, a small body, difficult coordination and they are inexperienced. At this age, they are also developing a natural curiosity for the environment, which makes them prone to be exposed to dangerous situations. They are also unable to avoid certain body positions that can lead to severe injuries and asphyxia, and can't protect themselves against maltreatments and abuses.

There are other factors that contribute for the risk of injuries and traumatic death of children, like the characteristics of parents and caregivers, the parental practices for injury prevention, the characteristics of the residence, the location and the socio-economic status [6-8].

As children grow into adolescence, it is expected a healthy time with peaks in strength, speed, fitness and many cognitive abilities. However, with these advances come new life-threatening risks [9].

Adolescents are known to engage in risky behaviors, exemplified by drinking and driving, speeding, neglecting seat-belts, risk taking while driving, consuming illegal substances, running away from home, weapon carrying, auto theft and assault. They are also subjected to peer pressure.

Many adolescents also have a tumultuous period of maturation, trying to gain independence and transiting into adult society. This often comes with an increase in anxiety and stress levels, which may lead to maladaptive feelings of hopelessness, personal failure and suicidal ideation.

Being suicide a concern among adolescents, the most studied risk factors are sociological, psychological or psychiatric. The lack of a cohesive family unit is known to be a risk factor for suicide ideation and it can be identified by poor parent-child communication, loss of a primary caregiver, parental violence, psychopathological disorders or legal difficulties [10,11].

Among violent deaths, although some percentages vary among studies, we can identify the most common causes of death for children and adolescents, and some of the trends of mortality in this age group.

It was identified that the three leading causes and mechanisms of death among this age group were traffic accidents, on the first place, followed by drowning and fire-related burns. The leading manner of death were accidents, followed by homicides and self-inflicted injuries. Most of the times, the major number of deaths belonged to male individuals, and the subgroups at most risk seemed to be pre-scholar children (0-4 years old) and adolescent males (15-18 years old) [6,12].

Nevertheless, this matter can also be analyzed by age subgroups or by regions, having some different, yet directed, results.

If we analyze violent deaths, separating children from adolescents, we can see that most of the children die by traffic accidents, followed by drowning and suicide, whereas in the adolescent group, most of them die by traffic accidents, followed by suicide and homicide [9].

For children under five years old, homicide is one of the leading manner of death and half of those are caused by maltreatment, which unfortunately is a common reality. It is estimated that maltreatment ends in fatality in 19-30% of times. Almost 80% of the fatal cases of children maltreatment belong to this age group [13,14].

One of the common ways for this physical abuse to end in fatality is through the shaken baby syndrome, which is difficult to recognize since it can leave no obvious exterior signs of the abuse. The majority of these victims are under the age of six years old, and half of them are under one year old [14].

Another known significant cause of death for infants under one year of age is accidental mechanical asphyxia, with reports of 11% due to unsafe sleeping circumstances [6].

In terms of locations, we can see many differences in the major causes and mechanisms of death by analyzing only one specific region.

For example, in Australia and some parts of the United States (US), drowning is the leading mechanism of death in children under five years old [6].

In the US, the major mechanism of infant death, and the second leading mechanism of death, for children and adolescents, after traffic accidents, are home accidents [15].

In contrast with other countries, where few children die by firearms, in the US, children are nine times more likely to die by firearm injuries then in other countries, being this one of the major causes of traumatic death among children, although one third of these deaths are unintentional [16].

As seen before, violent death is one of the leading causes of death in children and adolescents, and it has a significant importance since most of these deaths can be prevented [3].

As in other countries, in Portugal the role of the forensic pathologist is ultimately to enlighten the Court. To achieve this mission, besides the necropsy examination, he must consider and aid to the expert report other multidisciplinary data, such as the crime scene investigation, the clinical information, the police information, the social information and the results of ancillary investigations.

But the role of every forensic scientist must go way further than to just investigate criminal cases, giving the victims' families accurate answers on how or why such tragedies occurred, as they also should study and conceive appropriate measures to prevent future similar events [3,15].

As there is a lack of studies of mortality of children and adolescents in Portugal, the aim of this study was to review all autopsy cases of children and adolescents (0-17 years old), from the North region of the country, from 2008 to 2012, to provide data that can help to better understand the risks that children take and help to identify potentially preventable deaths and develop preventive measures to many of those deaths.

2. Materials and Methods

The North Branch of the National Institute of Legal Medicine and Forensic Sciences (Instituto Nacional de Medicina Legal e Ciências Forences, I.P. – INMLCF) is responsible for the medico-legal autopsies made in the North of Portugal. All the autopsies are conducted in the Main Branch (Porto) and in its eight offices located in Braga, Bragança, Chaves, Guimarães, Penafiel, Santa Maria da Feira, Viana do Castelo and Vila Real. The results of the medico-legal death investigations, including autopsy results, police and social records, relevant medical record findings and ancillary investigations are entered into an electronic database. In cases of violent deaths, like the

ones in this study, toxicological analyses are always executed, except if the victim survives more than 24 hours after the occurrence and therapeutic interventions are performed, blood transfusions are made or in cases where no blood is available, as occurs in advanced stages of putrefaction. These analyses always include search for alcohol, medicinal and illegal drugs, however, in the current study, only alcohol and illegal drugs were taken into account. Results pertaining to medicinal drugs were excluded from the study, even though there were few (n=4) cases with positive medicinal drugs analysis, because there was not enough data to know with certainty, in every case, if the children was medicated for some pathology and also because the medicinal drugs found were not at toxic or lethal levels.

For the purpose of this investigation, the INMLCF pathology service database was queried to identify violent deaths of children and adolescents.

In this investigation, a case was defined as any unnatural death, that occurred between 1 January 2008 until 31 December 2012, among Northern Portuguese residents, age <18 years old. In this study, and acording to the portuguese law, 18 years old is considered already an adult. The definition of the age range of children (0-11 y) and adolescent (12-17 y) was based on the age in wich, by the portuguese law, a child is already considered responsible for their actions.

Data were evaluated with respect to the following parameters: location where the autopsy was performed, year, season, age (categorized into six groups: 0-2 years, 3-5 years, 6-8 years, 9-11 years, 12-14 years, and 15-17 years), gender, cause and mechanism of death, manner of death and toxicological analyses.

Microsoft Office Excel 2010 was utilized to perform z-test with 99% confidence, to assess significant differences within the different variables, and frequency tables were generated using IBM® SPSS® (Statistical Package for Social Sciences) Statistics version 20 software.

3. Results and Discussion

3.1. General (n=151; 100%)

All expert reports of forensic autopsies concerning violent deaths, in children aged 0-17 years (n=151) performed in the North of Portugal, from January 1, 2008, to December 31, 2012, were retrospectively reviewed. Although the number of cases may appear to

be low, it is comparable to other similar studies, like one performed in Nebraska [3] with 140 cases of childhood deaths in a 7-year period, from which 98 were unnatural, or another study concerning teenager unnatural deaths in northern Sweden [11], with 355 cases within a 10-year period. These 151 cases represented 1.38% of the total forensic autopsies performed during the same period (n=10,906) and 2.76% of all the violent deaths that occurred. These results showed a considerably lower percentage of children's violent deaths when compared to the Nebraska study [3], where childhood deaths represented 7.6% of the total autopsies performed. The Main Branch of the INMLCF showed to be the location with most autopsies performed, with almost half of all the autopsy cases (47.7%). This tendency was observed in all manners of death, except homicides, but the low number of assault cases (n=5), can be the reason why this tendency is not seen in this manner. Those higher numbers can be explained since the North Region has a population of 3,689,682 and the North Branch of INMLCF is responsible for all the autopsies regarding an area which comprises one third of this population (1,238,478) [17] (Table 1).

Table 1 Manner of death distribution by the location where the autopsy was performed

Manner of death	Location where the autopsy was performed									*Total*
	Main branch of INMLCF	Offices								
		Braga	Bragança	Chaves	Guimarães	Penafiel	Sta. Ma. Feira	Vna. Castelo	Vila Real	
Accidental	63 (47.7%)	13 (9.8%)	4 (3%)	2 (1.5%)	10 (7.6%)	22 (16.7%)	5 (3.8%)	11 (8.3%)	2 (1.5%)	*132 (100%)*
Suicide	4 (40%)	1 (10%)	0 (0%)	0 (0%)	2 (20%)	1 (10%)	1 (10%)	0 (0%)	1 (10%)	*10 (100%)*
Homicide	1 (20%)	3 (60%)	0 (0%)	0 (0%)	1 (20%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	*5 (100%)*
Undetermined	3 (75%)	1 (25%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	*4 (100%)*
Total	*71 (47%)*	*80 (53%)*								*151 (100%)*

Throughout the studied period (Table 2), the overall number of deaths remained significantly similar ($p>0.01$) from 2008 to 2009, decreasing continuously until 2012 to a minimum of 22 cases (14.6%). The maximum number of deaths was observed in 2009 (37 cases), corresponding to 24.5%. A decrease in the number of cases with time was also observed in the Johansson et al. [11] study, with accidents being, in both studies, the manner of death responsible for such decrease.

Table 2 Manner of death distribution throughout the studied period, by year

Manner of death	Year										*Total*	
	2008		2009		2010		2011		2012			
	Counts	%	Counts	%	Counts	%	Counts	%	Counts	%	*Counts*	*%*
Overall	*36*	*23.8*	*37*	*24.5*	*31*	*20.5*	*25*	*16.6*	*22*	*14.6*	*151*	*100*
Accidental	31	23	31	23	28	21	21	16	21	16	*132*	*100*
Suicide	4	40	2	20	1	10	2	20	1	10	*10*	*100*
Homicide	0	0	2	40	2	40	1	20	0	0	*5*	*100*
Undetermined	1	25	2	50	0	0	1	25	0	0	*4*	*100*

In this study, most of the deaths (39%) occurred in the summer period (Table 3). The seasonal results are in accordance with the results obtained in Sweden [11], where May through September accounted for 54%, while in this study, in approximately the same time period (spring and summer), accounted for 62%. There is a clear predominance of deaths during summer and this tendency is observed in all manners of death and also for the two major mechanisms of death (Tables 3 and 4). Summer is the time of the year when children are on vacation, so the amount of leisure activities increases and so does the risk they are at. Children are often left with free time and little supervision, which becomes a risk especially for the younger ones. The mobility in the streets increase, with more pedestrians and bicycle riders, increasing the risk of traffic accidents. The activities near water also increase in the summer, and with it the risk of drowning.

Table 3 Seasonal distribution of the manners of death

Manner of death	Season								*Total*	
	Spring		Summer		Autumn		Winter			
	Counts	%	Counts	%	Counts	%	Counts	%	*Counts*	*%*
Overall	*34*	*22.5*	*59*	*39.1*	*28*	*18.5*	*30*	*19.9*	*151*	*100*
Accidental	30	22.7	51	38.6	24	18.2	27	20.5	*132*	*100*
Suicide	3	30	4	40	2	20	1	10	*10*	*100*
Homicide	1	20	3	60	0	0	1	20	*5*	*100*
Undetermined	0	0	1	20	2	40	1	20	*4*	*100*

Table 4 Seasonal distribution of traffic accidents and accidental drowning

Mechanism of death	Season								*Total*	
	Spring		Summer		Autumn		Winter			
	Counts	%	Counts	%	Counts	%	Counts	%	*Counts*	*%*
Traffic accident	18	22	28	34.1	20	24.4	16	19.5	*82*	*100*
Accidental drowning	5	20	14	56	0	0	6	24	*25*	*100*

Overall, accident was the most predominant manner of death (n=132; 87.4%), followed by suicide (n=10; 6.6%), homicide (n=5; 3.3%) and undetermined (n=4; 2.6%). Accidents have been reported, by the World Health Organization (WHO) [12], to be the

major manner of death in children. This study is in accordance with the Johansson et al. study [11], which reported accidents to account for 70%, followed by suicides (24.8%) and homicides (4%). However, Johansson et al. [11] only studied adolescents and, in this study, when considering only the adolescents, accidents accounted for 83.1%, suicides for 11.2% and homicides for 2.2%. Other studies, like the one from Okoye and Okoye [3], also reported accidents to be the leading manner of death in children, followed by suicide and, at last, homicide. However, there are studies where the homicides percentage was the same as suicides [1], or even higher [4]. These higher homicide percentages may be a consequence of the overall levels of violence existing in the US, where both studies were conducted.

Portugal, as a Mediterranean country, has a different social and cultural background than many other countries, which can influence many of the studied factors [18]. For instance, Portugal has lower rates of violence than the USA, and that will reflect on the homicide rates, which are lower in Portugal. Also, owning a firearm is more difficult in Portugal, so deaths by firearms are lower than in the USA [16]. In Portugal, because of the religious education, the suicide rates are also lower than in non-Catholic countries, among other examples [18].

Traffic accidents comprised 82 cases (54.3%), being the major overall cause of death, and drowning being the second, comprising 27 cases (17.9%). Traffic accidents have been found to be the major contributor for accidental deaths in childhood in developed countries, in all ages [9,12]. This study is in accordance with those findings, as well as with the New Mexico study [1], where traffic accidents were found to represent 69% of the accidental events. Our findings regarding drowning are also in agreement with the WHO report on child injury prevention [12], where the leading causes for childhood death are traffic accidents, followed by drowning. The other causes of death identified are shown on Table 5.

Table 5 Ranking of the overall causes/mechanisms of death

Rank	(n; %)
1st	Traffic accidents (82; 54.3)
2nd	Drowning (27; 17.9)
3rd	Firearm discharge (7; 4.6)
4th	Train-person collision (5; 3.3) Carbon monoxide intoxication (5; 3.3)
5th	Falls (4; 2.6) Fire-related injuries (4; 2.6) Hanging (4; 2.6)
6th	Exposure to mechanical forces (3; 2)
7th	Stabbed (2; 1.3) Eletrocution (2; 1.3) Inhalation of gastric content (2; 1.3)
8th	Foreign body aspiration (1; 0.7) Suffocation (1; 0.7) Bitten by dog (1; 0.7) Intoxication by ingestion of a organophosphorus pesticide (1; 0.7)

One study, that analyzed the unintentional childhood mortality in Europe (1984-93), found Portugal to have the highest mortality rate (23.1 *per* 100 000) out of the 14 countries studied, which decreased throughout the years (to 13.8 *per* 100 000), but did not change Portugal's position in the ranking. Traffic accidents were the leading manner of death, followed by drowning, fire and flames, and falls. In 1993 Portugal ranked 1st for traffic accidents, 6th for drowning, 1st for fire and flames and 2nd for falls [19].

This study revealed that male victims outnumbered female victims by 92 (60.9%) to 59 (39.1%), showing a male/female ratio of 1.56:1. This higher number of male victims is, although with a lower percentage, in accordance with several other studies, like the one performed by Okoye and Okoye [3], with 70% males, or the Johansson et al. [11], with 75%, a fact that is widely described in the literature. Both males and females were at higher risk of dying from accidents than from intentional injuries (90.2% and 83.1% of all cases, respectively), and then again, more at risk of suicide than dying from homicide.

The victims' average age was 11.1 years old. Regarding the age group (Table 6), there were 22 victims (14.6%) in the (0-2 y) age group. This number decreased to 11 (7.3%) in the (3-5 y) age group, and then there was an increase of the number of deaths with age till a peak of 58 cases (38.4%) in the (15-17 y) age group. Following the two adolescent groups, the infants (0-2 y), is the third age group with more cases registered. These results are only partially in agreement with the findings of other studies [1,3], in

which (0-1 y) age group is where the majority of the deaths occurred, followed by the oldest group. This disagreement with our findings may result from the fact that, in both those studies, natural deaths were also accounted for, which may explain why the highest number of deaths is registered in the (0-1 y) age group. A study about global patterns [9] showed that, in Europe, the (15-19 y) age group had about the double of victims than the (10-14 y) group, which is in accordance with our results, as it is the study by Batalis and Collins [4], which identified those two distinct groups of adolescents and showed the older group to be more likely to die from violent deaths, and the younger by natural causes.

Male victims almost doubled from childhood to adolescence [32 cases in (0-12 y) to 60 cases in (13-17 y)], while female victims remained almost the same [30 cases in (0-12 y) to 29 cases in (13-17 y)]. Males showed to be more at risk than females at all age groups, except in the (3-5 y) and in the (9-11 y) age groups, where female victims exceeded males, by 5 and 3 cases, respectively (data not shown). This increase of cases with the increase of age found in males was previously reported by Patton et al. [9], with European males increasing from 49 cases in the (10-14 y) age group to 125 in the (15-19 y) group.

Table 6 Distribution of the manner of death by age group

Manner of death	Children								Adolescents				*Total*	
	(0-2)		(3-5)		(6-8)		(9-11)		(12-14)		(15-17)			
	Counts	%	Counts	%	Counts	%	Counts	%	Counts	%	Counts	%	*Counts*	*%*
Overall	*22*	*14.6*	*11*	*7.3*	*12*	*7.9*	*17*	*11.3*	*31*	*20.5*	*58*	*38.4*	*151*	*100*
Accidental	21	15.9	11	8.3	10	7.6	16	12.1	27	20.5	47	35.6	*132*	*100*
Suicide	0	0	0	0	0	0	0	0	3	30	7	70	*10*	*100*
Homicide	1	20	0	0	1	20	1	20	0	0	2	40	*5*	*100*
Undetermined	0	0	0	0	1	25	0	0	1	25	2	50	*4*	*100*

All “Falls”, “Inhalation of gastric content”, “Foreign body aspiration”, “Bitten by dog” and “Intoxication by ingestion of a organophosphorus pesticide” cases were accidental, with (0-5) year old victims, and all “Hanging” cases were suicides committed by adolescents.

No toxicological analyses were performed in 73 cases, corresponding to 48.3%, because of the previously explained reasons. Out of the cases where toxicological analyses were performed, 64 subjects (42.4%) tested negative for alcohol and recreational drugs, 12 (7.9%) tested positive for alcohol and 2 (1.3%) tested positive for tetrahydrocannabinol. The results pertaining to alcohol presented a small percentage when compared to the

results reported by Johansson et al. [11], with 28% positive analyses, which is understandable considering that their subjects were only teenagers and that, in their study, 18 and 19 years old were accounted for, which are ages in which the youngsters are already permitted to drive in Sweden. The alcohol use is associated with death by drinking and driving, so it is expected, in a study which includes drivers, to have more positive analyses related with that fact.

Some risk factors that are described in the literature, as potentially associated to these kinds of deaths, were possible to identify in 57 cases (37.7%), mostly by the social and police information available (Table 7). Those represented 48 accidental cases, 5 suicides and 4 homicides. The risk factors identified included 2 cases with history of deviant behavior and 2 cases of history of recreational drugs use, 5 cases of incorrect traffic practices and 7 cases of incorrect pedestrian practices. There were 8 cases of illegal accommodation in vehicle, 3 cases of no seat-belt usage, 5 grand theft autos, 2 cases related with no driving license, 3 cases of children with no swimming skills, 2 breaches of safety standards, 12 cases related with poor supervision, 7 unsafe structures, 3 cases of intra-family violence and 2 incorrect product storage. With only one case each, there was association with physical aggression, suicide ideation, suicide letter and a previous suicide attempt. There were also 14 cases with positive toxicological analyses, which show association with substance use. It is worth mentioning that there are 19 cases in which more than one risk factor was identified.

Table 7 Risk factors

			Risk factor														
Manner of death	Cause of death	Case number	Positive toxicological analyses	History of recreational drug use	History of deviant behaviour	Incorrect traffic practices	Incorrect pedestrian practices	Illegal accommodation in vehicle	No seat-belt used	Grand theft auto	No driving license	No swimming skills	Breach of safety standards	Physical aggression	Poor supervision	Unsafe structure	Incorrect product storage
Accidental	Traffic accident	1				x											
		2					x										
		3						x									
		4	x														
		5												x			
		6					x										
		7						x									
		8					x										
		9				x				x	x						
		10				x				x	x*						
		11						x		x							
		12				x											
		13	x					x		x							
		14	x					x		x							
		15	x														
		16	x														
		17						x	x								
		18						x	x								
		19						x	x								
		20					x										
		21					x										
		22				x											
		23					x										
	Drowning	24													x	x	
		25											x				
		26											x				
		27													x		
		28										x					
		29										x					
		30													x	x	
		31	x														
		32													x	x	
		33	x														
		34													x	x	
		35													x	x	
		36										x					
		37													x		
		38	x														

* The victim was not the vehicle's driver

Table 7 Risk factors (cont.)

Manner of death	Cause of death	Case number	Risk factor														
			Positive toxicological analyses	History of recreational drug use	History of deviant behaviour	Incorrect traffic practices	Incorrect pedestrian practices	Illegal accommodation in vehicle	No seat-belt used	Grand theft auto	No driving license	No swimming skills	Breach of safety standards	Physical aggression	Poor supervision	Unsafe structure	Incorrect product storage
Accidental	Falls	39													x		
		40														x	
	Fire-related injuries	41													x	x	
		42													x		
	CO intoxication	43	x														
		44	x														
	Train-person collision	45					x										
	Inhalation of gastric contents	46													x		x
	Firearm discharge	47		x	x												
	Intoxication by ingestion of a organophosphorus pesticide	48													x		x

Manner of death	Cause of death	Case number	Positive toxicological analyses	History of recreational drug use	History of deviant behaviour	Intra-family violence	Suicide ideation	Suicide letter	Previous suicide attempt
Suicide	Hanging	49							x
		50				x			
	Firearm discharge	51	x						
	CO intoxication	52						x	
	Drowning	53					x		

Manner of death	Cause of death	Case number	Positive toxicological analyses	History of recreational drug use	History of deviant behaviour	Intra-family violence
Homicide	Firearm discharge	54	x	x	x	
		55	x			x
		56	x			
	Stabbed	57				x

3.2. Accidental (n=132; 87.4%)

Although the number of cases may appear to be low when in comparison with the 833 cases of the Yayci et al. [6] study in Istanbul, it is comparable with other studies, like the one conducted in Nebraska [3], where 71 accidental cases were reported from 2003 to 2010.

These accidental cases represented 3.85% of the total accidental autopsies made in the same period, in all the North Branch of INMLCF. The accidental children's deaths represented 87.4% of all the children's violent deaths, while the overall accidental deaths represented 62.6% of all the violent deaths. This percentage (87.4%) is higher than the percentage found in Nebraska [3], where accidents accounted for 72.4% of the violent deaths, or Istanbul, where the percentage was 47.3% [6]. The most important aspect to retain is that, if children's deaths are in their majority resultant of accidental events, they can be more easily prevented.

As expected, being accidental events the major component of this sample, we can observe that the results regarding accidental events follow the same behavior as the overall results seen before.

The number of accidental deaths was 31 (23%) in 2008 and 2009 (Table 2). From 2009 until 2011, the number of accidents decreased, remaining the same in 2012 (21 cases, corresponding to 16%). This decrease is in accordance with the findings of Lathrop [1] that reported accidental death rates to decrease from 2002 to 2010, and Johansson et al. [11], who also found transportation-related deaths to decrease throughout their study period. The majority of the cases were registered in the summer (Table 3).

The leading accidental traumatic event was traffic accident (Table 8), with 82 cases (62.1%), followed by drowning, with 25 cases (18.9%). Each of the other accidental events registered were responsible for less than 10% of the cases. There were no accidental cases of hanging or suffocation. WHO report [12] and the European study [19], both reported, as previously mentioned, traffic accidents to be the leading mechanism in accidental events, followed by drowning. Fire and flames, and falls are the mechanisms that follow. This study showed the same behavior, and is also in accordance with several other studies [1,3,6,11], in which traffic accidents and drowning are, respectively, the first and second leading mechanisms, although with variable percentages among the studies.

Table 8 Ranking of the causes/mechanisms of death for each manner of death

Accidental		Suicide		Homicide		Undetermined	
Rank	Cause/mechanism (n; %)	Rank	Cause/mechanism (n; %)	Rank	Cause/mechanism (n; %)	Rank	Cause/mechanism (n; %)
1st	Traffic accident (82; 62.1)	1st	Hanging (4; 40)	1st	Firearm discharge (3; 60)	1st	Train-person collision (2; 50)
2nd	Drowning (25; 18.9)	2nd	Firearm discharge (2; 20) CO intoxication (2; 20)	2nd	Stabbed (1; 20) Suffocation (1; 20)	2nd	Drowning (1; 25) Firearm discharge (1; 25)
3rd	Falls (4; 3) Fire-related injuries (4; 3)	3rd	Train-person collision (1; 10) Drowning (1; 10)				
4th	Exposure to mechanical forces (3; 2.3) CO intoxication (3; 2.3)						
5th	Train-person collision (2; 1.5) Inhalation of gastric contents (2; 1.5) Eletrocution (2; 1.5)						
6th	Foreign body aspiration (1; 0.8) Firearm discharge (1; 0.8) Stabbed (1; 0.8) Bitten by dog (1; 0.8) Intoxication by ingestion of a organophosphorus pesticide (1; 0.8)						

Once again, male victims outnumbered female victims by 83 (62.9%) to 49 (37.1%). This pattern has been extensively documented in the European and international literature [1,6,11,19], with male percentages ranging from 63% up to 75%. The gender differences observed are explained by the biological development of children. Males usually have more frequent and more severe injuries than females and this is observed already within the first year of life for most types of injury. Some explanations include that males engage in more risk taking than females, that they have higher activity levels or that they have a more impulsive nature [12]. There were 21 victims aged (0-2 y) (15.9%) (Table 6). The number of victims decreased in the (3-5 y) age group, remaining with no significant difference ($p>0.01$) until they start to increase with age at the (9-11 y) age group, till a maximum value of 47 victims (35.6%) in the (15-17 y) age group. Unintentional injuries are the leading manner of death for children throughout the world [12], accounting for over 40% of all deaths in people aged (10-24 y). The age groups at most risk are children belonging to the (0-4 y) and (15-18 y) groups, being the latest the one with higher percentages, with values ranging from 39% up to 56% [3,6]. As such, the results obtained in this study, pertaining to the age groups, are in agreement with the findings of those other studies, and can be explained by the natural biological development of children in which their ability to understand and respond to danger does not always correspond to their curiosity and wish to experiment [6].

Accidental male victims increased from childhood to adolescence from 31 cases (37.3%) to 52 cases (62.7%), while the number of female victims decreased from 27 (55.1%) to 22 (44.9%). Males were more at risk than females at all age groups, except in the (3-5 y) and in the (9-11 y) age groups, where female victims exceeded males, by 5 and 2 cases, respectively (data not shown).

There were 68 cases (51.5%) where no toxicological analyses were performed. Fifty-four subjects (40.9%) reported negative toxicological analyses. Nine (6.8%) subjects tested positive for alcohol, comprising 5 traffic accidents, 2 drowning and 2 carbon monoxide intoxications. One case of drowning (0.8%) tested positive for tetrahydrocannabinol.

It was possible to identify 48 accidental cases (31.8%) with risk factors (Table 7). Of those cases, 23 were identified in traffic accident cases, 15 in drowning cases, 2 in falls, 2 in fire-related injuries, 2 in carbon monoxide intoxications, one in a train-person collision, an inhalation of gastric content, a firearm discharge and an intoxication by ingestion of organophosphorus pesticide, each. The risk factors identified 5 incorrect traffic practices, 7 incorrect pedestrian practices, 8 illegal accommodation in the vehicle, 3 cases of no seat-belt usage, 5 grand theft autos, 2 cases associated with no driving license, 3 cases associated with lack of swimming skills, 2 breaches of the security standards, 12 cases associated with poor supervision, 7 unsafe structures, 2 incorrect product storage, and one case of history of recreational drug use, history of deviant behavior and physical aggression, each. There were also 10 cases of positive toxicological analyses. From those cases, 17 had more than one risk factor identified.

In order to prevent accidental deaths, an injury risk assessment must be made regarding a broad range of factors like environmental, socioeconomic, social, accommodation and family factors. After this risk assessment being made, directed at a specific situation, a wide range of prevention approaches are needed to reduce the children death risk. This should include multiple approaches at various levels such as legislation, regulations and standards, product modification, supportive home visiting, environment modification, promotion of safety devices, supervision of home-safety measures, educational programs for children and caregivers and community-based strategies.

Since “traffic accidents” and “drowning” were the leading events that lead to death, with such great expression, they will be presented in the two following subsections.

3.2.1. Traffic accidents (n=82; 54.3%)

There were 82 cases of children´s traffic accident related deaths, corresponding to 5.1% of all traffic accident related autopsies performed in all of the North Branch of INMLCF throughout the studied period. This is a small percentage when compared to the world percentage which is 21% [12]. Those cases represented 62.1% of the children's accidental deaths and 54.3% of all the children's violent deaths, which are higher, comparing to the overall corresponding population, in which traffic accident related deaths represented 47% of the accidental deaths and 29.4% of all violent deaths. As such, traffic accidents hold the leading position on children's violent deaths, which is in accordance with the 56.9% found by Pavlekic and Puzovic [5], but higher than the global 30% reported by WHO [12]. The 62.1% value is also higher than the findings of Okoye and Okoye [3], who reported this mechanism to be responsible for 46.5% of the accidental deaths.

From 2008 to 2009 (Table 9), traffic accident cases remained the same (20 cases, corresponding to 24.4%), decreasing to 14 cases (17.1%) and remaining with no significant difference ($p>0.01$), from 2010 to 2011, suffering another slight decrease to 13 cases (15.9%) in 2012. Even with traffic accident deaths decreasing with time, it is still a major preventable mechanism of death were action needs to be taken. The majority of the deaths happened during summer (Table 4), like in Belgrade, where April, July, August and September were the months in which the majority of the deadly traffic accidents occurred [5].

Table 9 Traffic accidents distribution by age and by year group

Age (years)		Counts	%	**Year**	Counts	%
Children	(0-2)	8	9.8	2008	20	24.4
	(3-5)	5	6.1	2009	20	24.4
	(6-8)	8	9.8	2010	14	17.1
	(9-11)	11	13.4	2011	15	18.3
Adolescents	(12-14)	17	20.7	2012	13	15.9
	(15-17)	33	40.2	*Total*	*82*	*100*
Total		*82*	*100*			

There were more male (51 victims, corresponding to 62.2%) than female victims (31 victims, corresponding to 37.8%). This higher percentage of male victims is in

agreement with the findings regarding accidental events and it has been extensively reported that boys are more frequently fatally injured than girls [3,5,11,12].

There were 8 victims (9.8%) in the (0-2 y) age group (Table 9), this value decreased to 5 victims (6.1%) in the (3-5 y) age group and then the number of deaths increased with age till the maximum of 33 cases (40.2%) in the (15-17 y) age group. This behavior follows the general tendency and is in accordance with the WHO global results [12] that reported traffic accidents to be the leading mechanism of death, together with drowning and animal bites, in children aged (5-9 y), and becoming the most significant unintentional injury among children aged (10-17 y). The group at most risk shown in this study were males aged (15-17 y), which can be explained because adolescents tend to travel more independently than younger children, who are more likely to be supervised by parents [12].

The majority of the traffic accidents (Table 10) were collisions, with 34 cases (42%), followed by run-overs (29 cases, corresponding to 35%) and non-collisions, with 19 cases (23%). Most of the victims were pedestrians (29 victims, corresponding to 35.4%), followed by car occupants, with 27 cases (32.9%), comprising 17 collisions and 10 non-collisions, and pedal cyclists, with 14 cases (17.1%), comprising 12 collisions and 2 non-collisions.

Pedestrians were also the majority of the victims in Belgrade, accounting for 57.4% [5] of the traffic accidents fatalities, and globally this type of victim represents 33% [12], which is similar to our findings. In Sweden [11] only 11% of the victims were pedestrians, with drivers ranking first in victim type, but these results have to be carefully taken into account since, in that study, the subjects were teenagers ranging from 13 through 19 years old, which means that, a considerable part of them, were already permitted to drive (52% of the traffic accidents victims were drivers).

Many studies relate pedestrian deaths to a high number of incorrect pedestrian traffic practices [5,9], as well as unsupervised young children [12], which also happened in some unspecified cases in this study. Car occupants had a percentage of 32.9% in the 82 victims of traffic accidents, being the second leading class of victims, although it is described that globally, percentages can go as high as 50% [12].

Table 10 Role of the victim in the different types of traffic accidents

Role of the victim	Type of traffic accident						*Total counts*
	Run-over		Collision		Non-collision		
	Counts	%	Counts	%	Counts	%	
Pedestrian	29	100	0	0	0	0	*29*
Pedal cyclist	0	0	12	35.3	2	10.5	*14*
Motorcycle ryder	0	0	5	14.7	1	5.3	*6*
Car occupant	0	0	17	50	10	52.6	*27*
Bus occupant	0	0	0	0	1	5.3	*1*
All-terrain vehicle occupant	0	0	0	0	1	5.3	*1*
Agriculture vehicle occupant	0	0	0	0	4	21.1	*4*
Total counts (% of type)	*29 (35)*		*34 (42)*		*19 (23)*		*82*

Some risk factors were identified in 23 cases (15.2%) of this study (Table 7). Those were 5 cases of incorrect traffic practices, 6 cases of incorrect pedestrian practices, 5 grand theft autos, which indicate deviant behavior, and 8 cases of illegal and unsafe accommodation in the vehicle. There was one event, with two resulting victims, where one of the victims was illegally, and uneducated, for driving the vehicle, and in 3 other cases the victims did not use seat-belts, which is also a risk factor described in literature [11]. One case of physical aggression led to a run-over case while the victim was trying to escape. There were 5 cases of positive toxicological analyses. Eight of these cases had more than one risk factor identified. Substance abuse by the drivers and speeding are other risk factors identified for traffic accidents [11,12]. These cases of car accidents, along with all other vehicle accidents, should be prevented with resource to combined measures such as education on better supervision, education of children on traffic regulation, seat-belts, child-seat restraint, speed limit and drug and alcohol laws [3,11,12].

3.2.2. Accidental drowning (n=25; 16.6%)

There were 25 cases of accidental drowning, corresponding to 92.6% of all cases of drowning. Those represent 18.9% of all children's accidental deaths, being the second leading mechanism of accidental death. This scenario is similar to the findings of Yayci et al. [6] in Istanbul, where drowning also ranked second and was responsible for 20.1% of the accidental fatalities. Drowning is the second leading mechanism of accidental deaths, accounting globally for 16.8% of the accidental deaths [12] and it was reported to be 12% in Europe in 1993 [19].

Drowning is a matter of great concern in Portugal every year, since children are at great risk of drowning because there is a great tendency, in the summer vacations, for children to swim in open waters, like in rivers or at the sea, where there are many known dangers, such as unknown depth of water, rocks and other obstacles or strong currents [12].

Cases of drowning remained, with no significant differences ($p>0.01$), throughout the studied period (Table 11), at 16-20% of cases per year, except in 2010 where there was a peak of drowning, with 7 cases (28%). These cases were predominant in the summer (Table 4).

Table 11 Accidental drowning distribution by age and by year group

Age (years)		Counts	%	**Year**	Counts	%
Children	(0-2)	6	24	2008	4	16
	(3-5)	1	4	2009	5	20
	(6-8)	0	0	2010	7	28
	(9-11)	1	4	2011	5	20
Adolescents	(12-14)	9	36	2012	4	16
	(15-17)	8	32	*Total*	*25*	*100*
Total		*25*	*100*			

There were more male victims (19 cases, corresponding to 76%) than females (6 cases, corresponding to 24%). Again, this overrepresentation of males compared to females has been found in other studies [3,12].

The number of victims was 6 (24%) in the (0-2 y) age group (Table 11), decreasing to 1 case (4%) in each of the age groups (3-5 y; 9-11 y), and no victim was found in the (6-8 y) group. It then increased to 9 cases (36%) in the (12-14 y), remaining, with no significant difference ($p>0.01$), in the (15-17 y). This high percentage in older youngsters is also present in Istanbul [6], with 15-18 years old accounting for 44.3% of the drowning.

Drowning was reported by WHO [12] to be the leading mechanism of death in children under 5 years old, however, this was not the case in our study.

From these cases, 15 (60%) were drowning in natural waters, 5 (20%) were cases of drowning in swimming-pools and 5 were cases of drowning in other specified places. There were 5 accidental drowning cases (9.9%) where risk factors were possible to identify (Table 7). Those were 7 cases related with poor supervision, 5 related with unsafe structure, 3 related with children with no swimming skills, 2 related with breach

of safety standards and 3 cases with positive toxicological analyses. There were 5 cases with more than one risk factor identified. Cases of drowning, whether in natural water or in swimming-pools, were mostly observed in male adolescents, associated with their curiosity and risk taking, which, according to the WHO report [12], tend to drown in natural water in open spaces. In the literature, they often relate them with substance abuse, however, in this study, only 3 subjects had positive toxicological analyses. Also, 3 cases were related to people with little or no swimming skills and 2 with breach of security standards, where adolescents went swimming with the security red flag up. Infants (0-2 y) had a smaller peak of drowning, due to their natural development. For younger children, high risks appear to be more proximate to home. Most drowning cases in this age group happens in water buckets or barrels, washing tanks, wells and other unsafe structure in or near home, when unsupervised by the caregiver [12] and, as seen, 5 cases were identified to be related to unsafe structures and 7 with poor supervision.

For the prevention of these kinds of deaths, a multiple action approach needs to be taken. This can include programs to improve children supervision, education on life-saving and cardiopulmonary resuscitation (CPR) for caregivers, encouragement of children not to drink while swimming, use of safety equipment, such as life vests, securing pools with safety barriers, covering wells and open barrels, creating fenced barriers near ponds, enforcing certain measures through legislation and regulations, swimming lessons including identification of dangers, mandatory supervising of beaches and swimming pools by trained lifeguards, and construction of safe and attractive venues for recreational swimming [1,3,12].

3.3. Suicide (n=10; 6.6%)

Suicide ranked second in the leading manners of deaths. The 10 cases registered corresponded to 0.64% of all the suicide cases in the overall population. This number of suicide cases is low in comparison with the study performed in Kentucky [10] where, in 10 years, 108 cases were reported of children between 11-17 years old.

The children's suicide cases represented 6.6% of all the children's violent deaths, when suicides, in the corresponding population, represented 28.4% of all the population's violent deaths. A study performed in Italy [18] stated that, in that country, as well as in Portugal and Spain, youth suicides are relatively rare, when compared with other

European countries like Finland and Norway, which is in accordance with our findings. In France, 16% of juvenile mortality is attributed to suicide [20], which is more than double of this study's percentage, and in Nebraska [3] this percentage was even higher (19.4%).

In our study, suicide began with 4 cases (40%) in 2008, decreased in 2009 and remained, with no significant differences ($p>0.01$), until 2012, with 1 or 2 cases (10 to 20%) (Table 2). Most cases of suicide were observed during summer (Table 3). However, it is stated that the season with most completed suicides is spring, and committed suicides and suicide attempts together are more frequent in summer. This difference is probably due to the reduced number of cases in this study [21].

The leading suicide method employed was hanging, with 4 cases (40%) (Table 8). There were 2 cases (20%) of firearm discharge and carbon monoxide intoxication each, one case (10%) of train-person collision and another (10%) of drowning in natural water. These results differ from the findings of most studies, where firearm discharge is the leading methodology to practice suicide [10,21]. In this study, suicide from firearm discharge was the second leading methodology, together with carbon monoxide intoxication. This can be a consequence of a more difficult access to firearms than in other countries. Hanging, which was the leading methodology in our study, is also described in the literature as being one of the most common practices [21], and ranked second in the study performed in Kentucky [10]. Similar results to ours, where hanging was first and firearms second, were found in Sweden [11] and Nebraska [3]. The high percentages of suicide by hanging may be explained by the easy access to the resources needed.

Although the overrepresentation of males has been constant throughout this study, and that fact has been described in several studies [10,3,11,18], this was not the case in the suicidal deaths, where there were the same number of male and female victims, with 5 cases each (50%/50%). This result can be explained by the low number of suicide cases in our study. However, there are some few studies that even report females to have higher suicide percentages than males, in China [18] and Turkey [21].

All the victims were adolescents and the risk of suicide increased with age, with 3 cases (30%) in the (12-14 y) age group and 7 cases (70%) in the (15-17 y) age group (Table 6). Female victims only outnumbered males, with 4 to 3 victims, in the (15-17 y) age group (data not shown). Suicide was only observed in teenagers, as in Okoye and Okoye [3] study, and increased with age, which is also in accordance with other studies

[3,21]. This increase may be explained by the increased psychopathology with age [18], among other factors.

No toxicological analyses were performed in 4 cases (40%). Out of the cases where toxicological analyses were performed, 5 subjects (50%) tested negative for alcohol and recreational drugs and 1 subject (10%) tested positive for alcohol, in a case of suicide by firearm discharge.

Risk factors were identified in 5 suicide cases (3.3%) (Table 7). Those were 2 hanging cases, one related with intra-family violence and the other with a previous suicide attempt, one case of firearm discharge related with positive toxicological analyses, one carbon monoxide intoxication related with a suicide letter and a drowning case related with a victim with suicide ideations. As it can be seen, there is no case with more than one risk factor identified.

It is known that the early recognition of suicide signs in children can be difficult [18] because of the natural secrecy and spontaneously generally involved in suicides [1,21]. However, the recognition of signs like stress, anxiety, depression, change in behavior, or other emotional or psychological signs is very important for suicide prevention and an adequate training for parents, teachers and physicians should be implemented [3,21,18].

3.4. Homicide (n=5; 3.3%)

Homicide was found to be the least common manner of death, with only 5 cases, representing 3.3% of children's violent deaths, with homicides in the corresponding population representing 3.71% of all the violent deaths. This percentage of homicides in children's violent deaths is in accordance with the Swedish study [11], where 4% of the violent deaths were homicides. This percentage changes when we look at different countries, like the US, which is known to have high levels of violence. In Nebraska [3], homicide was responsible for 7% of the childhood deaths and, in Detroit, in a study regarding the year 2002 [22], homicides accounted for 86% of the children and adolescents' violent deaths.

The children's homicide cases corresponded to 2.46% of all the homicide cases in the general population, in the North of Portugal.

Homicide cases were only registered between 2009 and 2011, and the number of cases remained similar ($p>0.01$) with time (1 or 2 cases; 20 or 40%) (Table 2). Although the

number of cases is very small to see a real tendency, summer was the season (Table 3) with most cases, which is in accordance with the McGowan et al. study [22], where it is said that most of the homicides take place during summer.

The majority of homicidal deaths were caused by firearm discharge, with 3 cases registered (60%), like in Detroit [22] where this method was responsible for 63% of the homicides. The remaining cases were one case (20%) of stabbing and one (20%) suffocation (Table 8).

Regarding the gender, there were more female victims (n=3; 60%) than males (n=2; 40%). In spite of this curiosity, the victim's number should be consider similar, as no significant difference ($p>0.01$) was observed. This result is in accordance with the results reported in the Detroit [22] and Swedish [11] studies. However, females showed to be more at risk in childhood and males in late adolescence (15-17 y) (data not shown).

No toxicological analyses were performed in only one subject (20%). One subject had negative toxicological analyses (20%), 2 subjects (40%) tested positive for alcohol and 1 subject (20%) tested positive for tetrahydrocannabinol. All positive subjects were cases of assault by firearm discharge.

In most homicides the perpetrator is often a male, a relative or an acquaintance of the decedent [1,3,11]. This was observed in this study, with 3 cases where the perpetrator was the parent. Risk factors discribed in the literature include peer interpersonal violence, substance abuse, psychiatric illness, depression and suicide ideation amongst parents, family problems (status of the marital relationship, family violence, child abuse and neglect) [1,4,11,22,23]. In this study there were 4 cases (2.6%) where risk factors were identified. There was a case of stabbing associated with intra-family violence and 3 cases of assault by firearm discharge: one associated with history of deviant behavior, history of recreational drugs use and positive toxicological analyses, another associated with intra-family violence and positive toxicological analyses and, at last, one with positive toxicological analyses. As seen above, there were 2 cases with more than one risk factor identified.

3.5. Undetermined manner of death (n=4; 2.6%)

There were 4 cases (2.6%) where the available data was not enough to determine the manner of death.

Two of those cases were train-person collisions, where there was a doubt if they were accidents or suicides. In both cases, the victims were female adolescents and the toxicological analyses were negative. In one case there were no witnesses, and the social information only refers that the victim had no known problems and that she should be at school at that hour. The other case was witnessed by the victim's boyfriend that stated they had a fight and she got in front of the train to get his attention, being accidentally hit. He also mentioned she did not have any other known problems.

Another case where it was not possible to distinguish between accident and suicide was a death by firearm discharge. The victim was a male adolescent, found dead in his room with his father's shotgun. There were no witnesses to the event. The family stated he was a quiet boy and his death was an accident motivated by his curiosity by his father's gun, since he had already asked to try it. The results of the toxicological analyses were also negative.

Finally, there was a case where it was not possible to determine whether the death was an accident or a homicide. This case was a death by drowning of a male child, which also had negative toxicological analyses. The social and police information reports that the victim's mother went to the river with the idea of drowning herself and her son, a fact confirmed by suicide letters found in her car. They were both rescued from the water but he was already dead. She stated he fell in the water and she was trying to rescue him. She showed no signs of remorse, saying only she wanted to go with him, because she could not stand to see him ill and not be able to help.

3.6. Toxicology

The percentages of positive analyses are very low, with only 9.3% of the overall victims testing positive for alcohol and recreational drugs. This is not in accordance with the literature, which refers that alcohol and substance abuse is severely related to child's death in all manners of death. Accidents are linked with this risk factor, mainly on adolescents, because of their natural experimentation behavior, which leads to several cases of traffic accidents, drowning, among others [12]. Cases like those can be seen in this study, although in small number. In other countries, where adolescents are permitted to drive, alcohol is also a major concern in traffic accidents, because of young drunk drivers [11]. That is not the case in Portugal, although drunk driving is still an issue because it is a major cause of traffic accidents and children still die as vehicle

passengers or pedestrians. Child supervisors also engage in drinking while supervising, which impairs their capabilities to properly take care of a child [12]. In cases of suicide, substance consumption is also mainly linked to a child getting the courage to get through with the suicide act [24]. There is an increase of anti-depressive medication consumption amongst youth, with described effects like increase tendency for suicide. Although little evidence is available on these effects, toxicology screening should include these types of analyses to permit studies about this subject and new tendencies on these legal drugs and other new emerging drugs, to guide policy-makers in developing programs and reduce negative consequences. It will even be useful for law enforcement agents and health physicians in their daily encounters with them [3]. In this study, even with only 10 suicide cases, only one had a positive alcohol analyses. Homicide is also related to substance abuse, and in this study, as previously seen, even with only 5 homicide victims, 2 had positive alcohol analysis and one had positive tetrahydrocannabinol analysis. However, substance abuse is more associated with the perpetrator and is only associated with the victim when it is related to some kind of deviant behavior, which seemed to be the case in one subject of this study. This low percentage of positive cases can be explained by the low number of subjects analyzed.

3.7. Strengths and limitations

The strength of this study is the completeness of the database used, since, by law, all violent deaths should have an autopsy performed. However, there are some limitations identified. The sample size was small for this kind of study. The study was done over a homogenous population and regarding a specific region of Portugal, which may not allow the generalization of conclusions to other populations with different cultural or demographic backgrounds.

Suicide cases can be underestimated. Suicide rates are lower in the Mediterranean countries than in other countries, but they can also be underestimated because of the existing cultural and religious stigma, which creates a greater reluctance in attributing suicide as the manner of death [18]. The weakness of suicide mortality data is well documented and this is especially related to the misclassification of violent causes of death [21,22,18].

3.8. Surveillance systems and systematic data collection

Reviews on children's violent deaths continue to show the importance of all the data related to children's injuries and deaths, such as autopsy reports or hospital records. This kind of data is essential in understanding the causes of injury, identifying groups at risk and prioritizing preventive interventions. Data raises awareness of the magnitude of this health problem, serving as evidence to convince policy-makers and others that improvement needs to be done. A systematic data collection system should be created, combined with improved hospital surveillance, more community-based surveys and other appropriate research [12,24]. In fact, in Portugal there is a system for surveillance of infant's mortality being currently developed, based on the existing daily mortality surveillance system (vigilância diária da mortalidade - VDM). This system comprises little data about the fatalities but, on the other hand, requires little investment, being a great example of cooperation between organizations. It is a promising tool to use in child mortality not only in Portugal, but also at European level [25].

Sweden is an example to follow since it was the first country to recognize the seriousness of this problem, passing from a country with more child injury death rates than the US, to the country in the world with the lowest child injury death rate. They accomplished this by having good surveillance data and research, by the application of regulation and legislation regarding safety, safety education campaigns, among other measures, and by establishing interagency cooperation, which created a sense of national responsibility in the society. Their efforts continue to be seen through studies which evaluate the effectiveness of their injury reduction measures, like the one of Johansson et al [11].

Portugal has few studies performed about this subject. Little data is available on children and adolescent's violent deaths in Europe, with the exception of Sweden, especially on Mediterranean countries. The differences in cultural and economic backgrounds make it extremely difficult to compare our results with some degree of confidence. This shows the need for more studies in Portugal, as well as throughout Europe. It also suggests that exchange of data globally, using the same type of coding, would be a great way to make data more comparable. More factors should be studied and that shows the need for a more complete database. Also, prevention strategies should be nationally implemented and studies should be performed to evaluate the

efficiency of those strategies and the current state of this public health issue in the country.

4. Conclusions

This study showed that, in the North of Portugal, children and adolescent's violent deaths represented, between 2008 and 2012, 1.38% of the total forensic autopsies performed and 2.76% of all of the violent deaths. Males, like in other countries, outnumbered females, and most of the victims were adolescents. The (0-2 y) was the age group, among children, with most registered victims. A decrease in total number of children and adolescent's violent deaths was observed in the last years of the study and summer was the season with most cases. Most of these deaths occurred as a result of accidental events, which accounted for 87.4% of the registered deaths. Suicides were the second manner of death, followed by homicides and undetermined. Traffic accidents (majorly collisions) and drowning were the major contributors for accidental deaths. Suicides were mostly committed by hanging and homicides by firearm discharge.

To better understand this issue, and the reality in Portugal, more research and studies are needed. Therefore, it is essential to create a national research program to study children and adolescent's violent deaths. This program needs to include the creation of a systematic data collection system that can offer tools for the permanent monitoring of the situation.

Prevention strategies need to be planed and implemented and, for that, risk assessments need to be made, to better understand the adequate measures to include in those strategies. This should be done with an interagency collaboration and creating community conscience. All the data collection system, research data and prevention collaborations, should try to tend to a global level, or at least an European level.

Hopefully, with a bigger effort by forensic pathologists, health-care providers, policy-makers, epidemiologists and others, it will be possible to better predict and prevent children and adolescent's violent deaths.

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References

1. Lathrop SL (2013) Childhood Fatalities in New Mexico: Medical Examiner-Investigated Cases, 2000–2010. Journal of forensic sciences 58 (3):700-704. doi:10.1111/1556-4029.12106

2. Stylianos S (1996) Traumatic childhood death: How well do parents cope?: R.C. Oliver and M.E. Fallat. J Trauma 39:303–308, (August), 1995. Journal of pediatric surgery 31 (3):449. doi:http://dx.doi.org/10.1016/S0022-3468(96)90764-2

3. Okoye CN, Okoye MI (2011) Forensic epidemiology of childhood deaths in Nebraska, USA. Journal of forensic and legal medicine 18 (8):366-374. doi:http://dx.doi.org/10.1016/j.jflm.2011.07.013

4. Batalis NI, Collins KA (2005) Adolescent death: a 15-year retrospective review. Journal of forensic sciences 50 (6):1444-1449

5. Pavlekic S, Puzovic D (2006) [Analysis of traffic accidents in children]. Srpski arhiv za celokupno lekarstvo 134 (9-10):427-431

6. Yayci N, Pakis I, Karapirli M, Celik S, Uysal C, Polat O (2011) The review of autopsy cases of accidental childhood deaths in Istanbul. Journal of forensic and legal medicine 18 (6):253-256. doi:http://dx.doi.org/10.1016/j.jflm.2011.04.009

7. Mooney H (2010) Less advantaged children are 17 times more at risk of unintentional or violent death than more advantaged peers. Bmj 341:c6795. doi:10.1136/bmj.c6795

8. Hong J, Lee B, Ha EH, Park H (2010) Parental socioeconomic status and unintentional injury deaths in early childhood: Consideration of injury mechanisms, age at death, and gender. Accident Analysis & Prevention 42 (1):313-319. doi:http://dx.doi.org/10.1016/j.aap.2009.08.010

9. Patton GC, Coffey C, Sawyer SM, Viner RM, Haller DM, Bose K, Vos T, Ferguson J, Mathers CD (2009) Global patterns of mortality in young people: a systematic analysis of population health data. The Lancet 374 (9693):881-892. doi:http://dx.doi.org/10.1016/S0140-6736(09)60741-8

10. Shields LBE, Hunsaker DM, Hunsaker JC (2006) Adolescent and Young Adult Suicide: A 10-Year Retrospective Review of Kentucky Medical Examiner Cases. Journal of forensic sciences 51 (4):874-879. doi:10.1111/j.1556-4029.2006.00164.x

11. Johansson L, Stenlund H, Lindqvist P, Eriksson A (2005) A survey of teenager unnatural deaths in northern Sweden 1981–2000. Accident Analysis & Prevention 37 (2):253-258. doi:http://dx.doi.org/10.1016/j.aap.2004.09.002

12. WHO, UNICEF (2008) World report on child injury prevention. In: al MPe (ed)

13. Klevens J, Leeb RT (2010) Child maltreatment fatalities in children under 5: Findings from the National Violence Death Reporting System. Child abuse & neglect 34 (4):262-266. doi:http://dx.doi.org/10.1016/j.chiabu.2009.07.005

14. Miehl NJ (2005) Shaken baby syndrome. Journal of forensic nursing 1 (3):111-117

15. Asirdizer M, Yavuz MS, Albek E, Canturk G (2005) Infant and adolescent deaths in Istanbul due to home accidents. The Turkish journal of pediatrics 47 (2):141-149

16. Miller M, Azrael D, Hemenway D (2001) Firearm availability and unintentional firearm deaths. Accident Analysis & Prevention 33 (4):477-484. doi:http://dx.doi.org/10.1016/S0001-4575(00)00061-0

17. Instituto Nacional de Estatística IP, Lisboa-Portugal (2012) Censos 2011 Resultados Definitivos - Região Norte. Instituto Nacional de Estatística, I.P.,

18. Campi R, Barbato A, D'Avanzo B, Guaiana G, Bonati M (2009) Suicide in Italian children and adolescents. Journal of affective disorders 113 (3):291-295. doi:10.1016/j.jad.2008.05.019

19. Morrison A, Stone DH (1999) Unintentional childhood injury mortality in Europe 1984-93: a report from the EURORISC Working Group. Injury prevention : journal of the International Society for Child and Adolescent Injury Prevention 5 (3):171-176

20. de Pourtales MA, Hazen C, Cottencin O, Consoli SM (2010) [Adolescence, substance abuse and suicide attempt by jumping from a window]. Presse medicale 39 (2):177-186. doi:10.1016/j.lpm.2009.03.012

21. Ağrıtmış H, Yaycı N, Çolak B, Aksoy E (2004) Suicidal deaths in childhood and adolescence. Forensic science international 142 (1):25-31. doi:http://dx.doi.org/10.1016/j.forsciint.2003.11.024

22. McGowan AK, Crosby AE, La Hasbrouck M, Boulton ML, Kanluen S, Maseru NA (2006) Child and adolescent violent deaths: an epidemiologic investigation. Journal of the National Medical Association 98 (2):158-164

23. Bourget D, Gagne P (2005) Paternal filicide in Quebec. The journal of the American Academy of Psychiatry and the Law 33 (3):354-360

24. Shiffler T, Hargarten SW, Withers RL (2005) The burden of suicide and homicide of Wisconsin's children and youth. WMJ : official publication of the State Medical Society of Wisconsin 104 (1):62-67

25. Nogueira PJ, Machado A, Rodrigues E, Nunes B, Sousa L, Jacinto M, Ferreira A, Falcao JM, Ferrinho P (2010) The new automated daily mortality surveillance system in Portugal. Euro surveillance : bulletin Europeen sur les maladies transmissibles = European communicable disease bulletin 15 (13)